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Measurement of UO_2F_2 samples containing 2 different isotopic compositions

R. Kips

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Technical report prepared for the JRC-EC-IRMM
under Action Sheet 36

Disclaimer and auspices

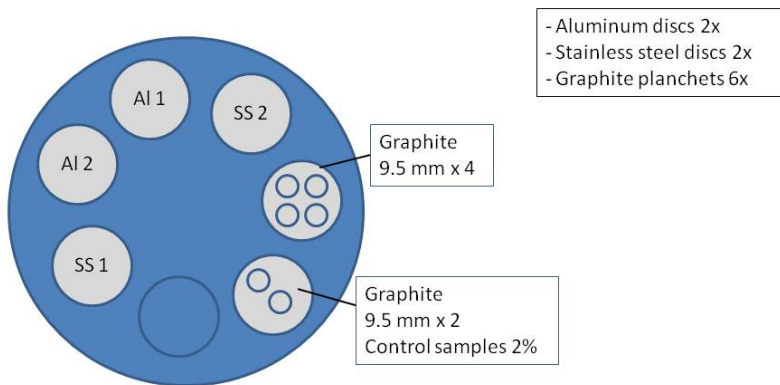
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This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 and under the auspices of the European Commission, DG Joint Research Centre under Action Sheet 36. The analyzed samples were generated by the IRMM expressly for the purpose of this experiment and we have no evidence that fugitive emissions from a uranium enrichment facility would, or would not, appear similar to the analyzed samples.

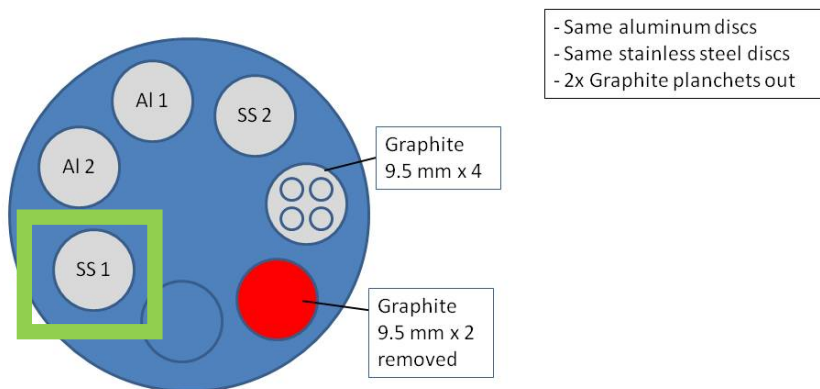
Measurement of UO_2F_2 samples containing 2 different U isotopic compositions (June 2010)

Samples prepared at IRMM in aerosol deposition chamber

Double deposition part 1: LEU 0.0208026 ± 0.0000337

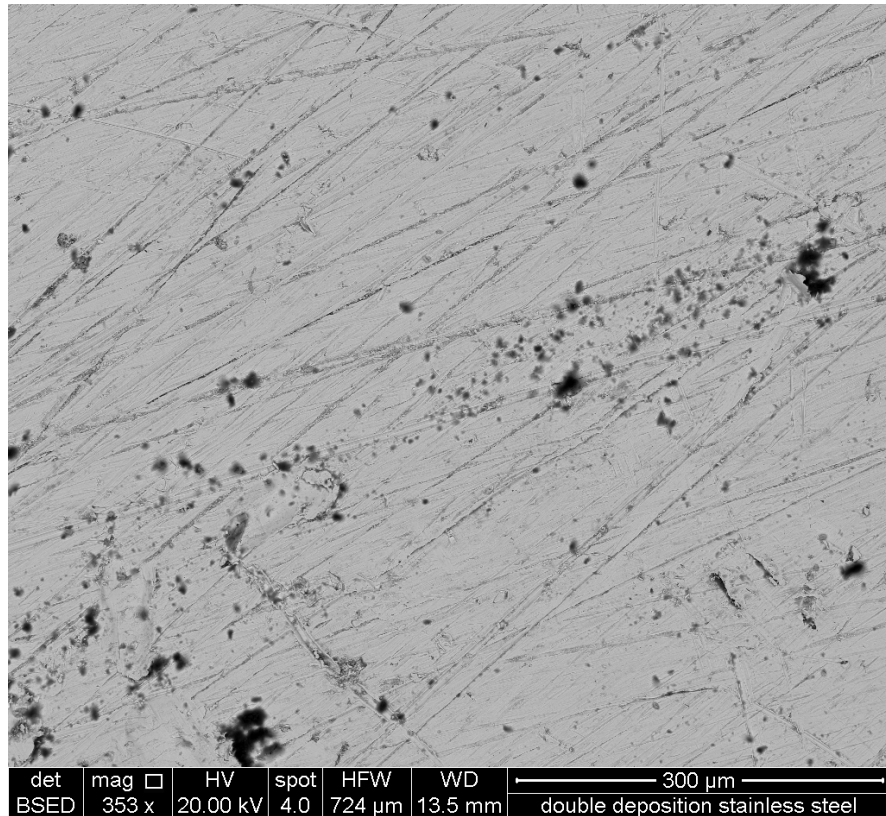


Double deposition part 2: HEU 0.254423 ± 0.002339

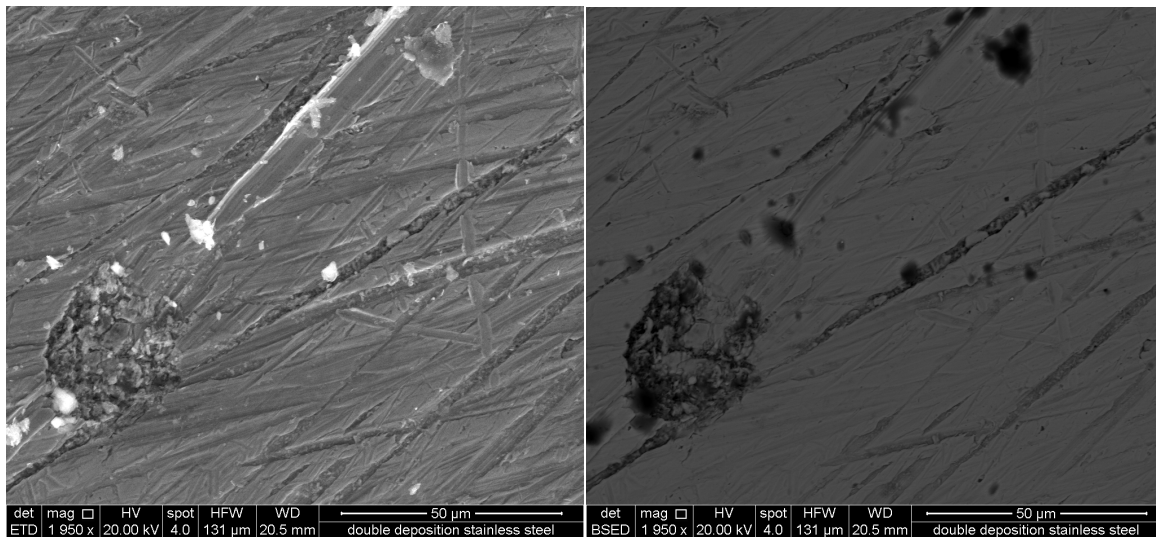


Stainless steel sample measured by SEM-EDX

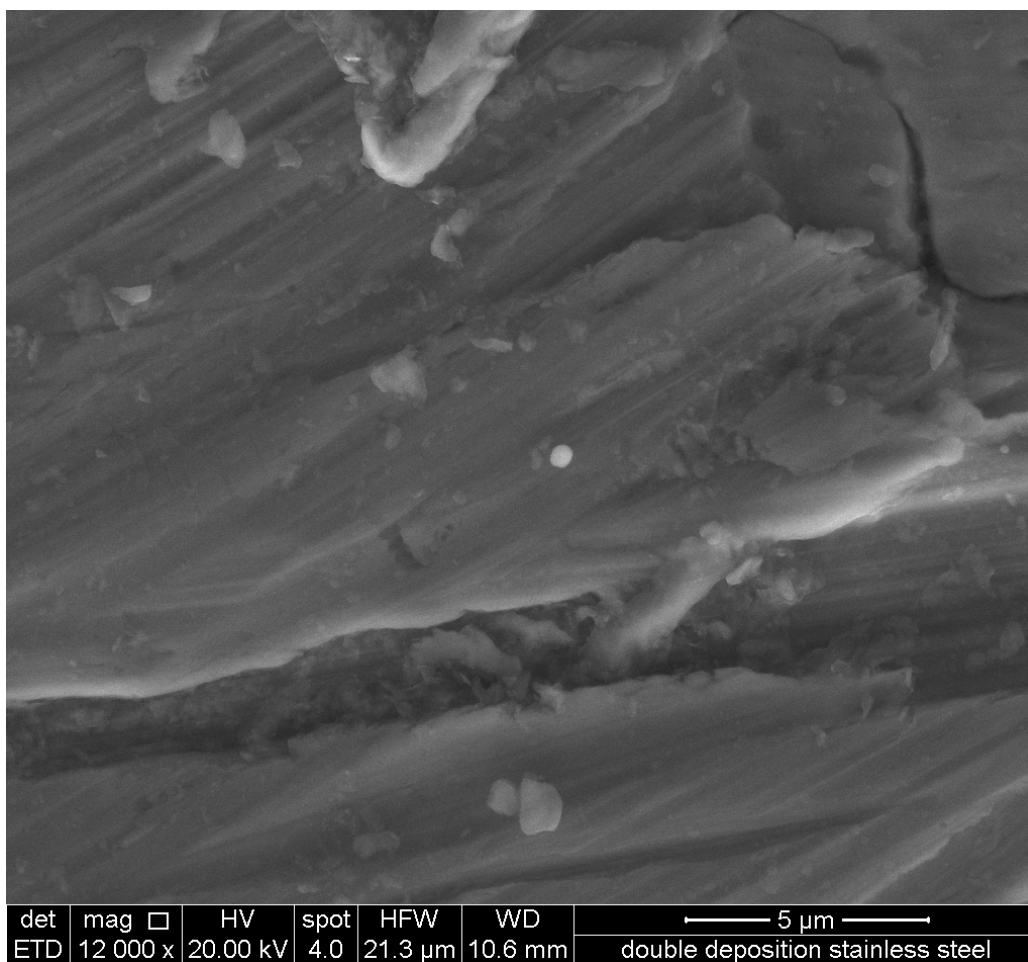
- Scanning electron microscope images show that the stainless steel surface is very rough, with many scratches
- A lot of particles that are NOT uranium, as shown on backscattered electron images
- Energy-dispersive X-ray analysis shows main components to be Fe, Cr, Ni, characteristic of stainless steel
- Confirmed at least 6 U-containing particles, these particles are typically ~ 500 nm in size



Backscattered electron image showing many scratches on stainless steel surface



Secondary (left) and backscattered electron (right) images at 1950x showing scratches and low-Z crud material, but no U



Secondary electron image of a submicron-sized uranium particle (center)

NanoSIMS analyses carried out on 6/29/2010

Fcp = 571 nA

Fco = 70 pA at L1: 0

Particle density very low, UO₂F₂ particles stored in dry air (< 20% RH)

Measurement conditions

EM4 EM5

	235
238	251
	254

1s wait time between each magnetic field jump

64 x 64 pixels - 1ms/pxl

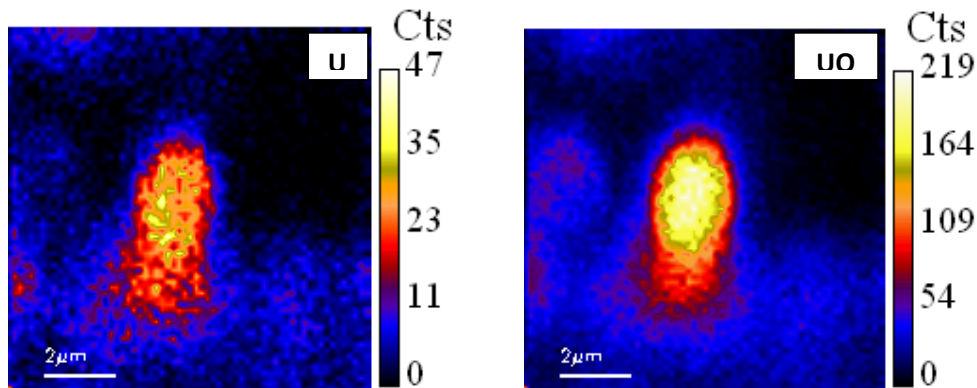
10 micron x 10 micron rasters

10-40 cycles

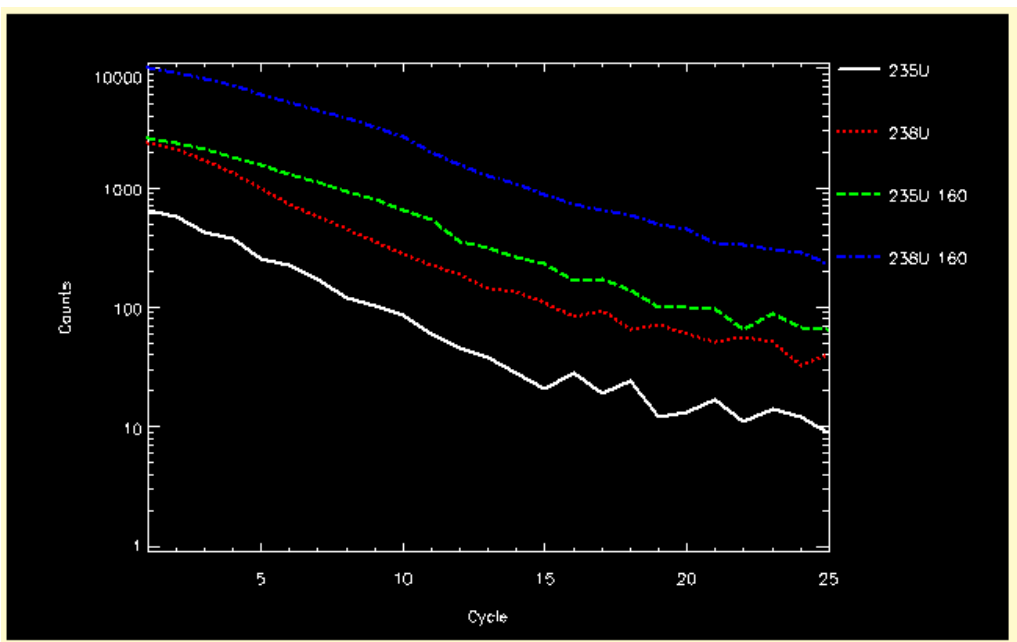
L1:0 and L1:1600

9 particles measured in center and on edge of stainless steel

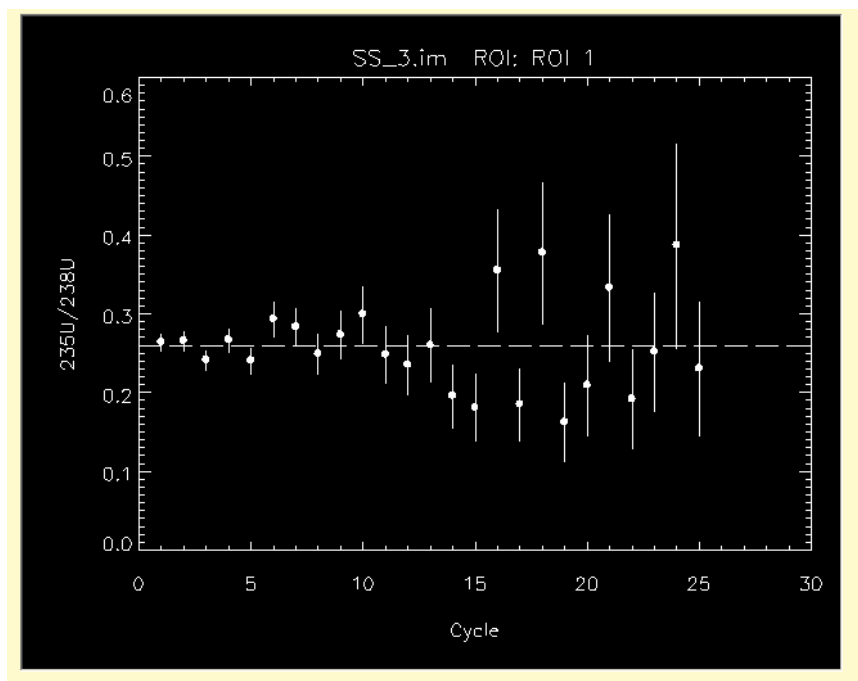
Particle #3 - average 235/238 ratio = 0.2605 ± 0.0051 (HEU)



Depth profile particle #3 25 cycles

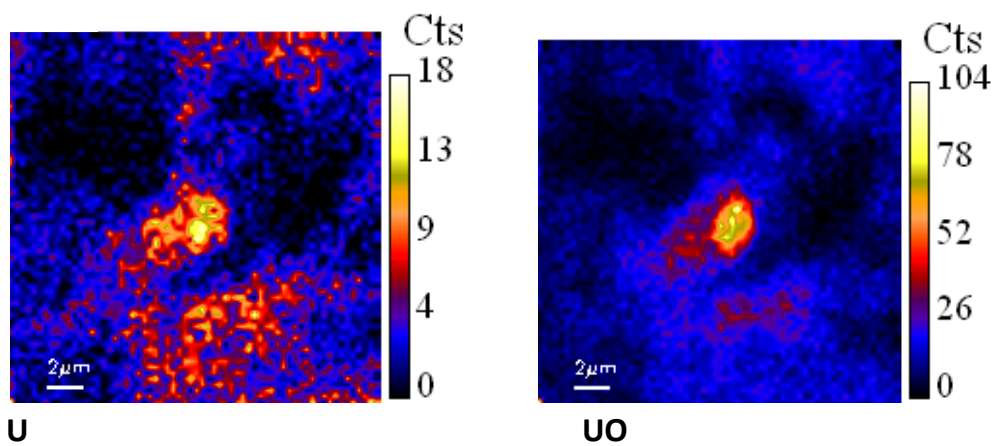


²³⁵U/²³⁸U ratio variations over 25 cycles

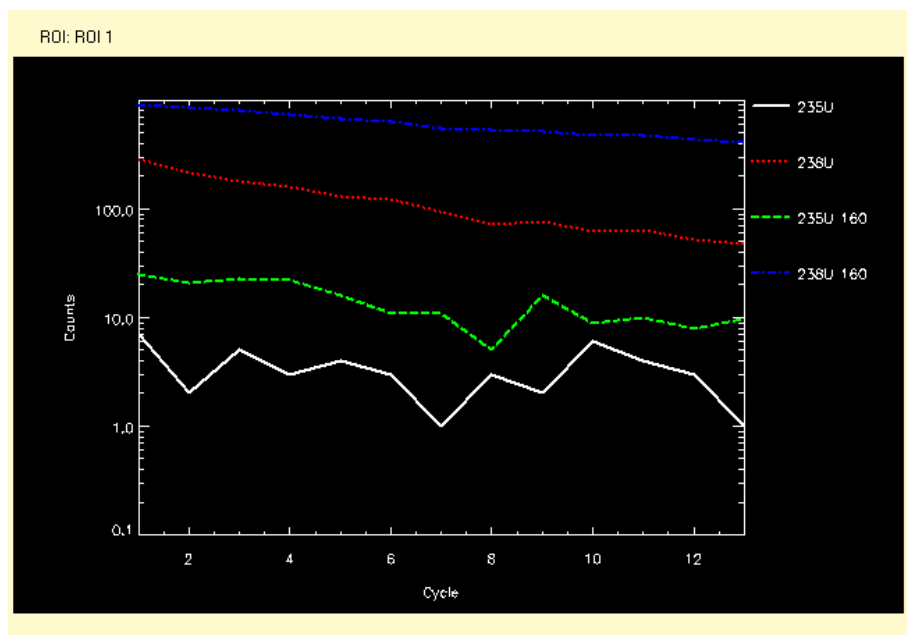


⇒ As count rate drops, spread on ratio becomes larger

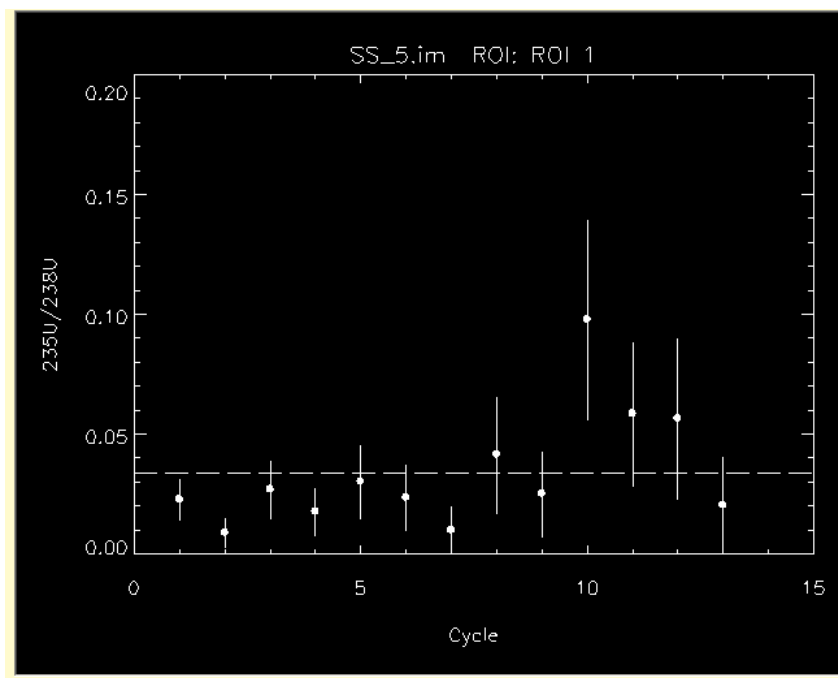
Particle #5 - average $^{235}\text{U}/^{238}\text{U}$ ratio = 0.0270 ± 0.0041 (LEU)



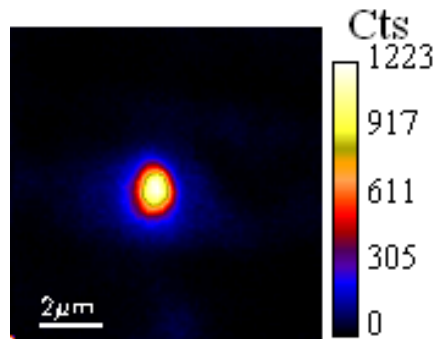
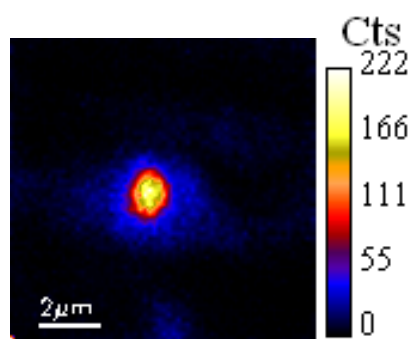
Very small particle, large U background

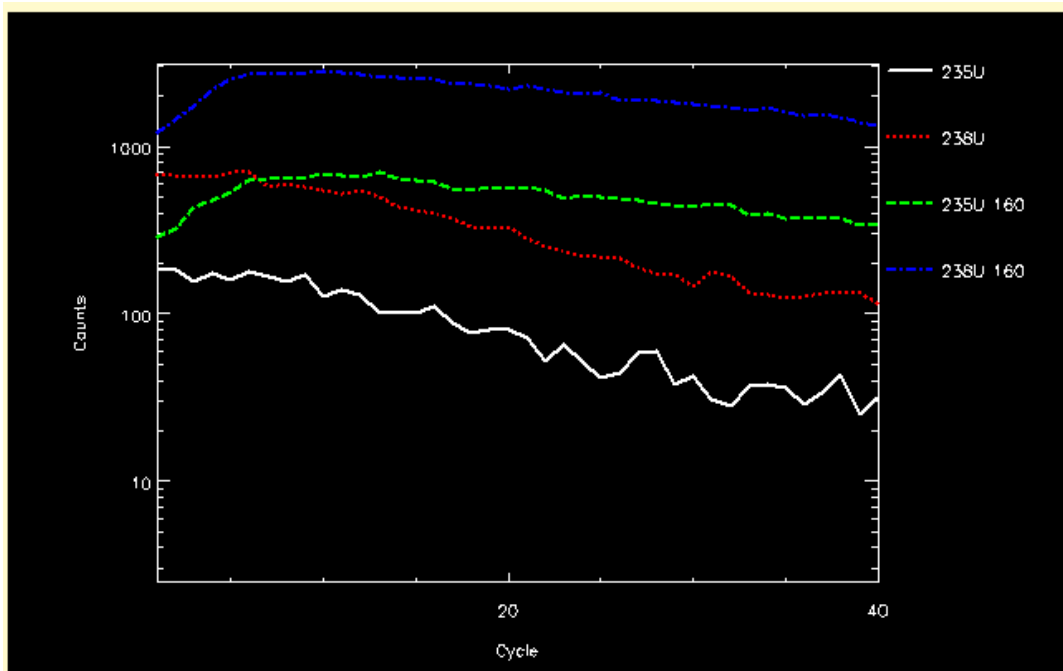


Log scale

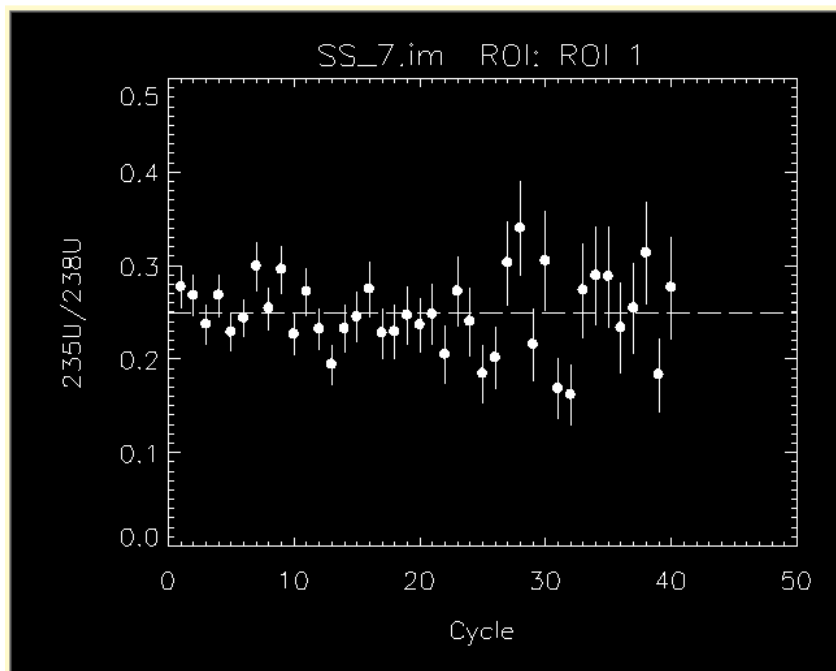


Particle #7 - average $^{235}/^{238}$ ratio = 0.2494 ± 0.0047 (HEU)

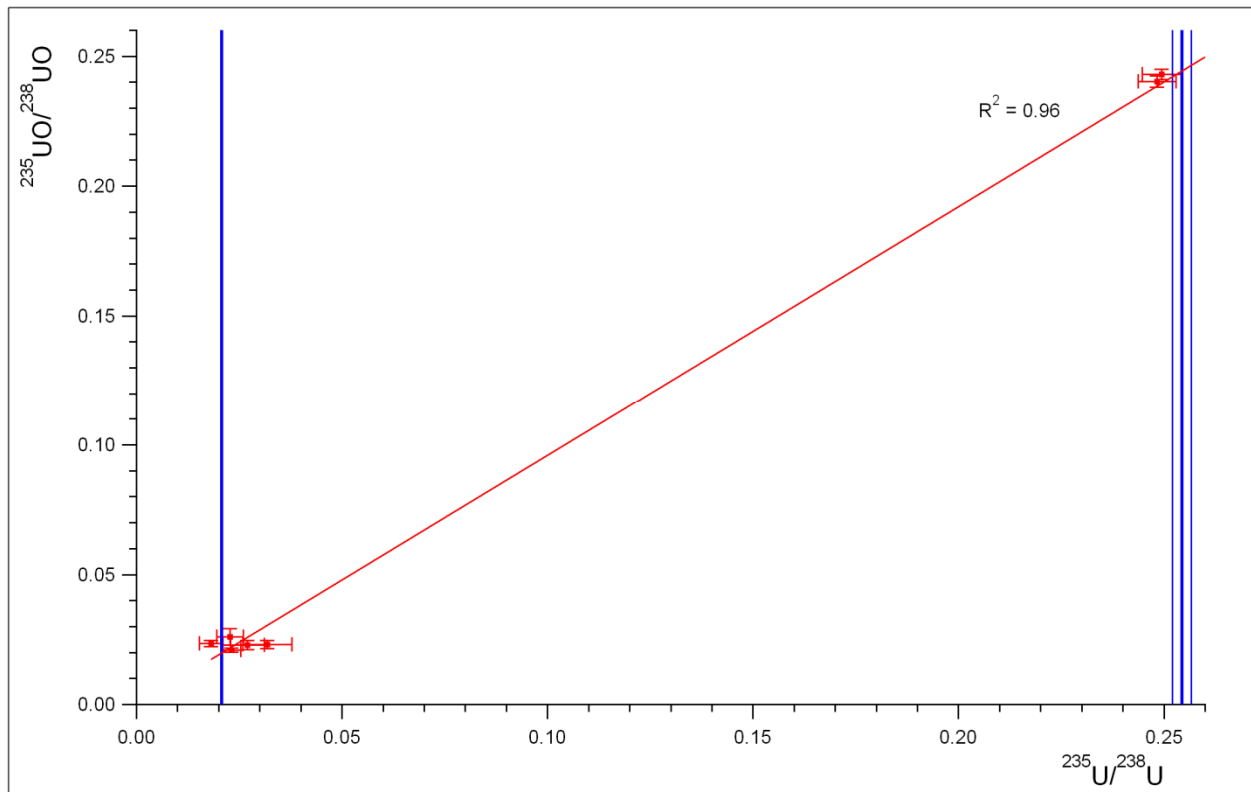




L1 = 0

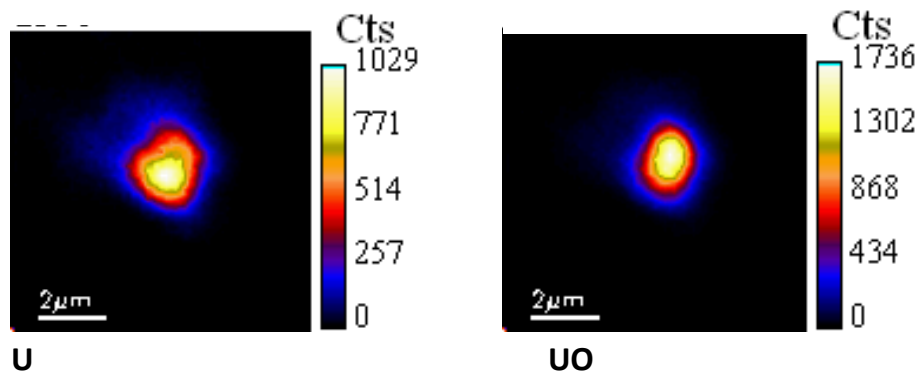


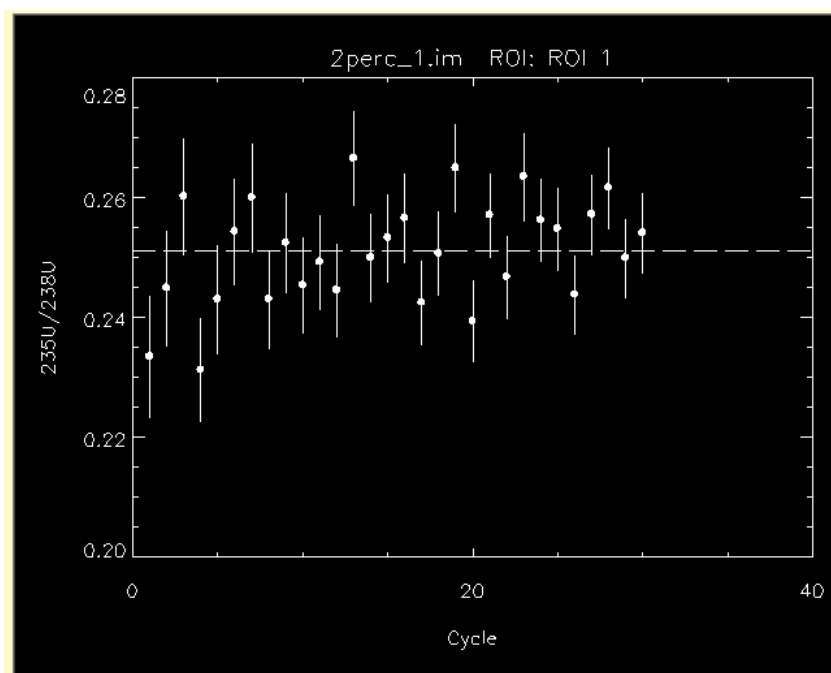
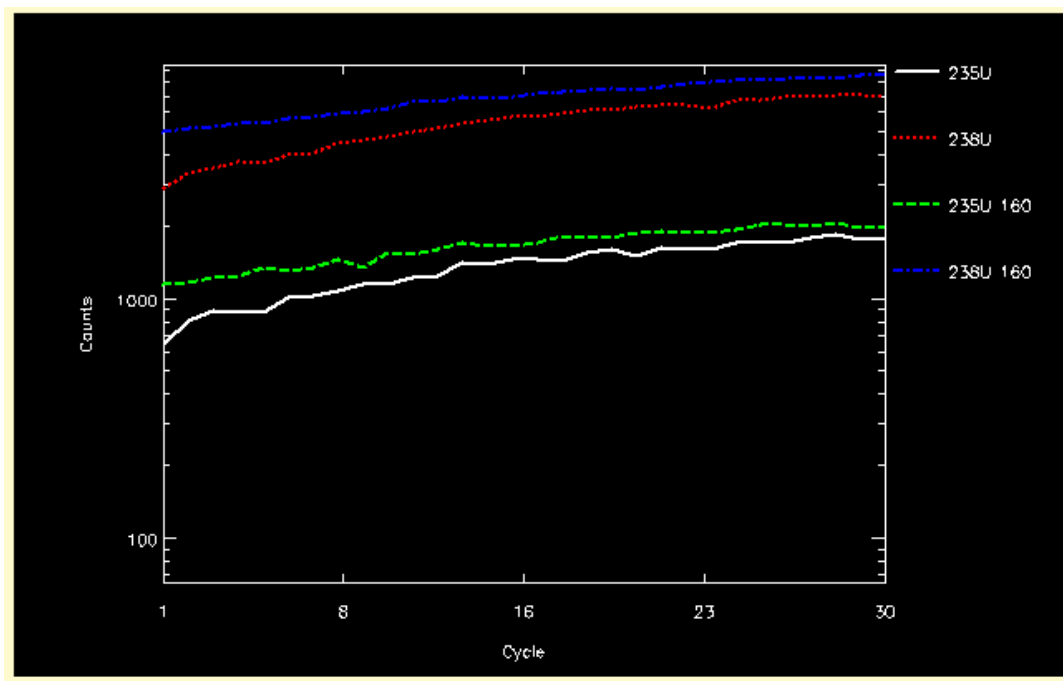
Overview of all particles analyzed



Blue lines indicate $^{235}\text{U}/^{238}\text{U}$ ratio of reference materials used for double deposition (LEU and HEU)

Verified isotopic composition of 20% enriched sample (1 isotopic composition)





Average 235/238 ratio = 0.2516 ± 0.0014 (HEU) within 1 stdev of reference value